AS Unit 1: Basic Biochemistry and Cell Organisation

Name:	Date:

Topic 1.2 Cell Structure and Organisation – Page 3

I. Eukaryotic Cells

i.) Under the electron microscope

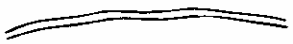
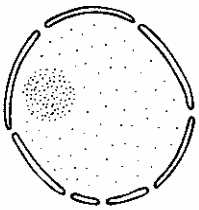
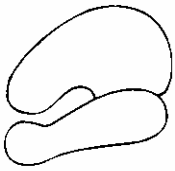
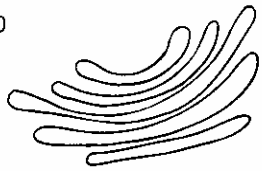
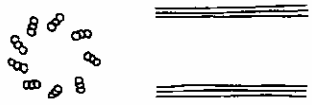
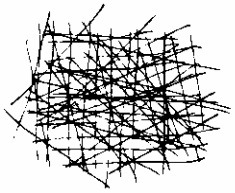
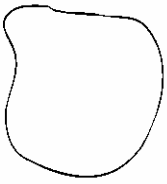
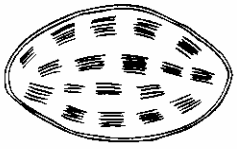
		Completed
1.	Read about the detailed structure of eukaryotic cells as seen under the electron microscope. • Rowlands p.26-30 • Handout **1.2e** (animal cell ultrastructure and a typical plant cell) • Go through the PowerPoint '**Eukaryotic Cells – Under the electron microscope' and 'A – Introduction to Cells'**	
2.	Answer the following questions: a. What is the '**ultrastructure**' of a cell? b. What is an **organelle**? c. What is meant by the term '**internal cell membrane'**? d. List in a table those organelles surrounded by a membrane and those that are not. e. What are the advantages to a cell of having organelles? In particular what are the advantages of membrane bound organelles.	
3.	Complete the activity on sheets **1.2f Cell Ultrastructure**	

W/S 1.2f Cell Ultrastructure

You will need to use your textbook and the Internet to help you with the following task:

Below are some organelles, which are commonly found in animal cells.

- Find out the name of each and write the name in the box next to the organelle.
- Cut out all the boxes and keep them safe.

x105 000  1	x3000  7 .....
x33 000  2	x1 240 000  8 .....
x27 000  3	x14 000  9 .....
x33 000  4	x54 000  10 .....
x20 000  5	x2000  11 .....
x5500  6	

W/S 1.2f Cell Ultrastructure

Below are some boxes, which give details about the structure and functions of the organelles you have cut out previously.

- Cut them out and match your picture of the organelle with their structure and function.
- Construct a table using your pieces of paper showing the organelles along with their structure and function.

Large organelle enclosed by a double membrane (an envelope) perforated by pores. Contains chromosomes and one or more nucleoli.	Very small organelle not bounded by a membrane. Consists of a large and a small subunit. Made of protein and RNA.
Stack of membrane-bounded, flattened sacs in cytoplasm, looking like a pile of pitta bread.	Form a spindle-shaped structure of protein fibres on which the chromosomes move during nuclear division.
A partially permeable barrier, which controls the passage of substances into and out of the cell.	Chromosomes contain DNA, which controls the synthesis of proteins. Ribosomes are formed in the nucleolus.
Provides mechanical support and protection. Prevents cell from bursting.	A pair of short cylinders. Each cylinder is made up of nine fibres.
The site of aerobic respiration and responsible for producing most of the ATP in a cell.	A sac bounded by a single membrane. Contains cell sap, which is a solution of mineral salts, pigments, organic acids and other substances.

W/S 1.2f Cell Ultrastructure

Forms a system of channels for transporting materials through the cytoplasm. One type has ribosomes on its surface and is the site of protein synthesis. The other type has no ribosomes and is where steroids and other lipids are synthesized.	Receives proteins synthesized on the ER and prepares them for secretion from the cell. This often involves adding carbohydrate to the proteins to make them into glycoproteins.
Responsible for destroying worn out organelles and for digesting the contents of vacuoles formed by phagocytosis.	Contains an outer membrane and an inner one which is folded to form cristae. Inside the inner membrane is the matrix containing enzymes, a circular DNA molecule and ribosomes.
A phospholipid bilayer with intrinsic and extrinsic proteins.	Consists of cellulose microfibrils and other polysaccharides.
Surrounded by two membranes. Contains a matrix called stroma which has a system of membranes running through it. These are stacked to form grana containing chlorophyll. Stroma contains circular DNA, ribosomes and starch grains.	A vesicle containing digestive enzymes.
A complex network of flattened membrane-bounded sacs called cisternae. Often has ribosomes on the cytoplasmic side.	The organelle in which photosynthesis takes place. Pigments capture the energy of sunlight and transfer it to chemical bonds.
Stores waste products and other substances. Changes in volume affect the turgidity of the cell.	Uses the information in nucleic acid to synthesise proteins.

W/S 1.2f Cell Ultrastructure

Using the summary chart and a textbook to help you answer the following questions:

1. Write a simple definition for each of the following words. Try to write the definition using your own words rather than just copying from a book or Internet.

   a. Plasma membrane _____

   b. Membrane _____

   c. Chromosome _____

   d. Partially permeable _____

   e. Synthesis _____

   f. Aerobic respiration _____

   g. ATP _____

   h. Polysaccharide _____

   i. Matrix _____

   j. Secretion _____

   k. Vesicle _____

   l. Microfibril_____

Extension

Construct a dichotomous key, based on structural differences, to identify the organelles you identified in your table.

Section C Membranes and transport

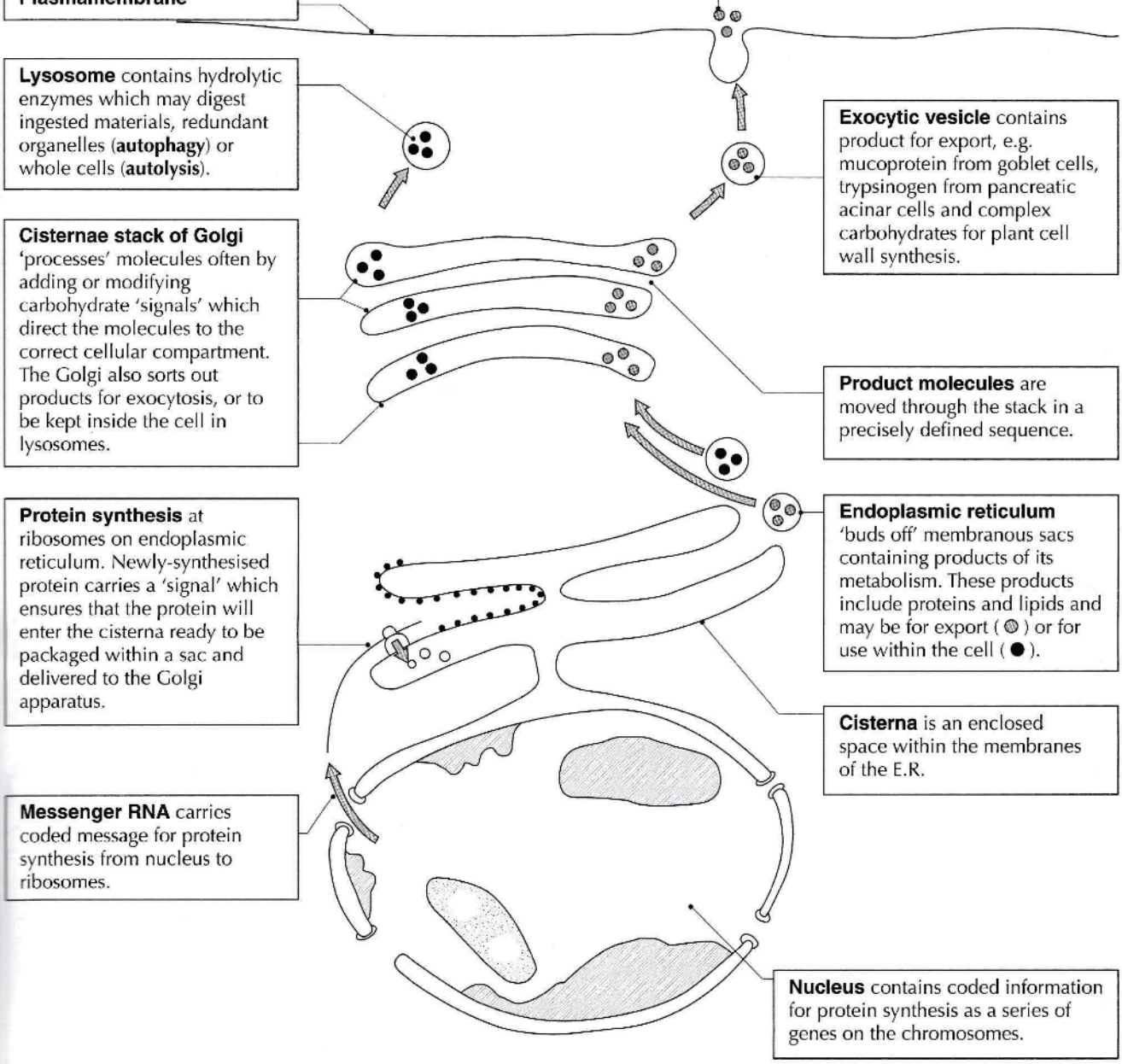
Cell membranes and organelles

are involved in the production and secretion of proteins.

Large molecules such as proteins cross membranes by a process called CYTOSIS. Energy (as ATP) is needed, and the process is made possible by the flexibility of the membrane.

Exocytosis: a vesicle containing the molecule fuses with the inside of the plasmamembrane and the molecule is expelled.

Endocytosis: the membrane recognises and binds to a molecule in its environment. The fluid membrane then forms a vesicle (sac) around the molecule, and the sac enters the cell. Phagocytosis (uptake of solids) and pinocytosis (uptake of fluids) are examples of endocytosis.

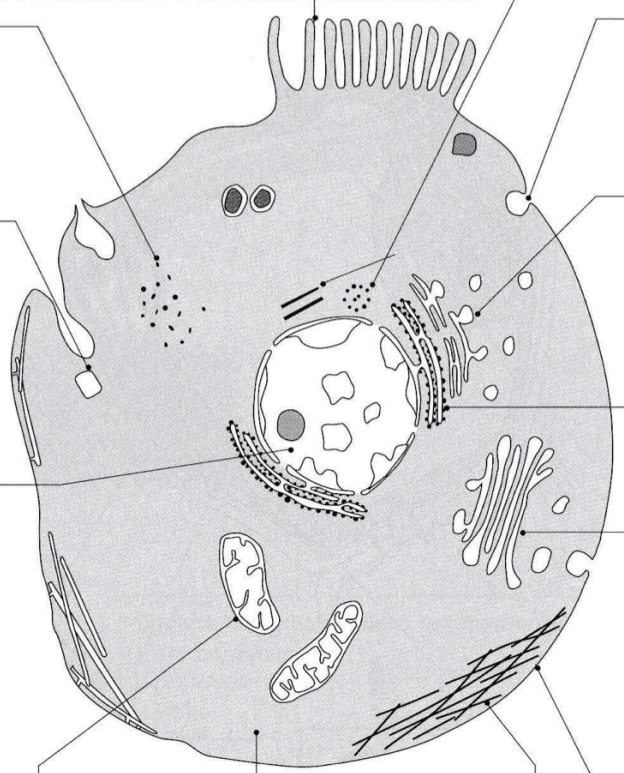


Outline of protein synthesis

DNA in nucleus ⟶ mRNA: moves to ribosomes ⟶ protein

TRANSCRIPTION TRANSLATION

Animal cell ultrastructure



Microvilli are extensions of the plasmamembrane which increase the cell surface area. They are commonly abundant in cells with a high absorptive capacity, such as epithelial cells of the small intestine or cells of the *first coiled tubule of the nephron*. Collectively the microvilli make up a *brush border* to the cell.

Centrioles are a pair of structures, held at right angles to one another, which act as organisers of the nuclear spindle in preparation for the separation of chromosomes or chromatids during nuclear division.

Free ribosomes are the sites of protein synthesis, principally for proteins destined for intracellular use. There may be 50 000 or more in a typical eukaryote cell.

Secretory vesicle undergoing exocytosis. May be carrying a synthetic product of the cell (such as a protein packaged at the Golgi body) or the products of degradation by lysosomes. Secretory vesicles are abundant in cells with a high synthetic activity, such as the cells of the *Islets of Langerhans*.

Endocytic vesicle may contain molecules or structures too large to cross the membrane by active transport or diffusion.

Smooth endoplasmic reticulum is a series of flattened sacs and sheets that are the sites of synthesis of steroids and lipids.

Rough endoplasmic reticulum is so-called because of the many ribosomes attached to its surface. This intracellular membrane system aids cell compartmentalisation and transports proteins synthesised at the ribosomes towards the Golgi bodies for secretory packaging.

Nucleus is the centre of the regulation of cell activities since it contains the hereditary material, DNA, carrying the information for protein synthesis. The DNA is bound up with histone protein to form chromatin. The nucleus contains one or more nucleoli in which ribosome subunits, ribosomal RNA, and transfer RNA are manufactured. The nucleus is surrounded by a double nuclear membrane, crossed by a number of nuclear pores. The nucleus is continuous with the endoplasmic reticulum. There is usually only one nucleus per cell, although there may be many in very large cells such as those of striated (skeletal) muscle. Such multinucleate cells are called coenocytes.

Golgi apparatus consists of a stack of sacs called *cisternae*. It modifies a number of cell products delivered to it, often enclosing them in vesicles to be secreted. Such products include trypsinogen (from *pancreatic acinar cells*), insulin (from *beta-cells of the Islets of Langerhans*) and mucin (from *goblet cells in the trachea*). The Golgi is also involved in lipid modification in cells of the ileum, and plays a part in the formation of lysosomes.

Mitochondrion (pl. mitochondria) is the site of aerobic respiration. Mitochondria have a highly folded inner membrane which supports the proteins of the electron transport chain responsible for the synthesis of ATP by oxidative phosphorylation. The mitochondrial matrix contains the enzymes of the TCA cycle, an important metabolic 'hub'. These organelles are abundant in cells which are physically *(skeletal muscle)* and

Cytoplasm is mainly water, with many solutes including glucose, proteins and ions. It is supported by the **cytoskeleton**, made up of microtubules and

Microfilaments are threads of the protein *actin*. They are usually situated in bundles just beneath the cell surface and play a role in endo- and exocytosis, and

Plasmalemma (plasmamembrane) is the surface of the cell and represents its contact with its environment. It is differentially permeable and regulates the movement of solutes between the cell and its environment. There are many specialisations of the membrane, often concerning its protein content.

Typical plant cell contains chloroplasts and a permanent vacuole, and is surrounded by a cellulose cell wall.

Handout 1.2

Cell wall is composed of long cellulose molecules grouped in bundles called **microfibrils** which, in turn, are twisted into rope-like **macrofibrils.** There may be a secondary cell wall containing **lignin** (gives strength to xylem) or **suberin** (makes a waterproof layer in the endodermis).
The function of the cell wall is a mechanical one - pressure from the cell protoplast maintains cell turgidity. The wall is freely permeable to water and most solutes so that the cell wall represents an important transport route - the **apoplast system** - throughout the plant body.

Chloroplast is the site of photosynthesis. It is one of a number of plastids, all of which develop from **proplastids** which are small, pale green or colourless organelles.

Vacuole may occupy 90% of the volume of a mature plant cell. It is filled with cell sap (a solution of salts, sugars and organic acids) and helps to maintain turgor pressure inside the cell. The vacuole also contains anthocyanins, pigments responsible for many of the red, blue and purple colours of flowers. Vacuoles also contains enzymes involved in recycling of cell components such as chloroplasts. The vacuolar membrane is called the **tonoplast.**

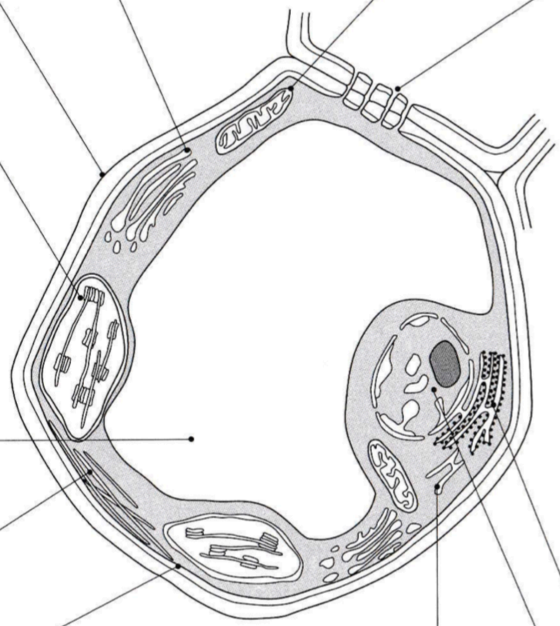
Microtubules are hollow structures (about 25 nm in diameter) composed of the protein tubulin. They occur just below the plasmamembrane where they may aid the addition of cellulose to the cell wall. They are also involved in the cytoplasmic streaming of organelles such as Golgi bodies and chloroplasts, and they form the spindles and cell plates of dividing cells.

Plasmamembrane (plasmalemma, cell surface membrane) is the differentially-permeable cell surface, responsible for the control of solute movements between the cell and its environment. It is flexible enough to move close to or away from the cell wall as the water content of the cytoplasm changes. The membrane is also responsible for the synthesis and assembly of cell wall components.

Golgi body (dictyosome) synthesises polysaccharides and packages them in vesicles which migrate to the plasmamembrane for eventual incorporation in the cell wall.

Mitochondrion contains the enzyme systems for ATP synthesis by oxidative phosphorylation. May be abundant in sieve tube companion cells, root epidermal cells and dividing meristematic cells.

Plasmodesmata are minute strands of cytoplasm which pass through pores in the cell wall and connect the protoplasts of adjacent cells. This represents the **symplast** pathway for the movement of water and solutes throughout the plant body. These cell-cell cytoplasm connections are important in cell survival during periods of drought. The E.R. of adjacent cells is also in contact through these strands.



Plant, animal and bacterial cells

Feature	Plant	Animal	Bacterium
Cell wall	✓ (cellulose)	✗	✓ (murein)
Nucleus	✓	✓	✗
Plasmids	✗	✗	✓
Mitochondria	✓	✓	✗
Ribosomes	✓	✓	✓ (but small)
Chloroplasts	✓	✗	✗
Permanent vacuole	✓	✗	✗

Rough endoplasmic reticulum is the site of protein synthesis (on the attached ribosomes), storage and preparation for secretion. The endoplasmic reticulum (E.R.) also plays a part in the compartmentalisation of the cell.

Smooth endoplasmic reticulum is the site of lipid synthesis and secretion.

Nucleus is surrounded by the nuclear envelope and contains the genetic material, DNA, associated with histone protein to form chromatin. The nucleus thus controls the activity of the cell through its regulation of protein synthesis. The nucleolus is the site of synthesis of transfer RNA, ribosomal RNA, and ribosomal subunits.